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蝶と蛾 *Trans. lepid. Soc. Japan* **59** (4): 267–276, September 2008

Immature stages of *Lopharcha* Diakonoff (Lepidoptera, Tortricidae, Chlidanotinae, Polyorthini), with description of a new species from Japan and an autapomorphy for the genus

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Abstract Immature stages of two species of *Lopharcha* Diakonoff are described. Immatures of *L. psathyra* Diakonoff feeding on *Neolitsea sericea* (Lauraceae) are illustrated for the first time. *L. kinokuniana* sp. nov. is described from Japan, with illustrations of the adult stage, including its genitalia, and of immature stages. The larvae rolled the leaves of *Cinnamomum japonicum* (Lauraceae). An autapomorphy for the genus is proposed on the basis of larval character.

Key words Tortricidae, *Lopharcha psathyra*, *Lopharcha kinokuniana* sp. nov., larva, pupa, autapomorphy.

Introduction

The genus *Lopharcha* (tribe Polyorthini) was erected by Diakonoff (1941) based on the type species, *L. quinquestriata* Diakonoff, 1941, from East Java. The genus ranges through the Oriental and Australian regions and over 20 species have been described (Brown, 2005; Nasu, 2006). The genus has a forewing with raised tufts of scales (*Acleris*-like), a membranous valva with a longitudinal split containing a hairpencil arising from the eighth segment in the male and bundles of spines (signa) in the corpus bursae in the female genitalia (Diakonoff, 1974). The former two characters are found in the other members of the Polyorthini, and the latter is sometimes absent. No autapomorphy for the genus has been proposed. The immatures of the genus are poorly investigated: only the larva of *L. insolita* (Dugdale, 1966) has hitherto been illustrated (Dugdale, 1966, as *Laciniella insolita*).

In Japan two species, *L. psathyra* Diakonoff, 1989 and *L.* sp. of Yanagita & Nakajima (1999), have previously been recorded. Through my research into Japanese Tortricidae, larvae of *L. psathyra* boring into the fruits of *Neolitsea sericea* (Lauraceae) and an undescribed species of the genus feeding on the leaves of *Cinnamomum japonicum* (Lauraceae) were discovered.

In the present paper I describe a new species, with illustrations of immature stages of the new species and *L. psathyra*, and propose an autapomorphy for the genus based on a larval character.

Materials and methods

The present study is based on specimens of Japanese *Lopharcha* collected by the author and other lepidopterists. Some *L. psathyra* were reared from larvae boring into the fruits of *Neolitsea sericea* and the new species of the genus was reared from larvae feeding on *Cinnamomum japonicum*. The following acronyms are used for the depositories of specimens: ATC—Collection of A. Tomisawa, Ishikawa Insect Museum, Hakusan-shi, Japan; TMC—Collection of T. Mano, Toyota Yahagi River Institute, Toyota-shi, Japan; UJC—Collection of U. Jinbo, Tokyo University, Tokyo, Japan; OPU—Entomological Laboratory

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of Osaka Prefecture University, Sakai-shi, Japan; YNC—Collection of Y. Nasu.

Male and female genitalia were dissected after being macerated for about 5 min. in 10% KOH heated in a waterbath, and after washing, stained with Chlorazol Black E. Larvae and pupae were usually fixed in KAAD fluid and stored in 95% ethanol. Larvae were slit lengthwise laterally and macerated for about 5 min. in 10% KOH heated in a waterbath, and after washing, stained with acetocarmine for examining the larval morphology. Photographs of genitalia and larval skins were taken using a digital camera "Nikon Coolpix 8400" attached to a binocular microscope "Nikon Eclips E200", and illustrations of larval chaetotaxy and pupae made using a drawing apparatus attached to a binocular microscope "Leica MZ16". Digital images of adult, genitalia and larvae were enhanced using Microsoft Photo Editor and Adobe Photoshop software.

Descriptions

Lopharcha psathyra Diakonoff, 1989 (Figs 1A–C, 2A, B, 3A, 4A, B, 5, 7A, B)

Lopharcha psathyra Diakonoff, 1989: 202.
L. psathyra: Oku *et al.*, 1997: 148; Sokawa & Mano, 1999: 292; Owada *et al.*, 2000: 134.

Larva (Figs 1B, C, 4A, B, 5). Last instar length about 13 mm. Head somewhat shorter than broad, brown: stemmatal area and galea dark brown (Fig. 4B); spinneret short, tapering distally. Prothoracic shield dark brown. Thoracic leg dark brown. Body brownish yellow, becoming reddish before pupating (Fig. 1B); integument spinulose (Fig. 5D). Crochets on ventral prolegs in a uniordinal circle, 22–25 (Fig. 5D); crochets on anal proleg in a semicircle, *ca* 15. Small circular plate present in antero-dorsad from ventral proleg on abdominal segments III–VI (Fig. 5D: arrow). Setae pale. Pinacula large, dark brown. Anal plate dark brown, pale medially (Fig. 5C). Anal fork present, spinulose triangular plate with 8–10 spines on the edge (Fig. 5E).

Chaetotaxy (Figs 4A, B, 5). On head, P1 closer to AF1 than to AF2, A2 closer to A1 than to A3. On abdominal segments I–VII, SD1 and SD2 antero-dorsad from spiracle, L group trisetose, L1 and L2 on a common pinaculum. On abdominal segment VIII, D1s, D2s, SD1 and SD2, L1 and L2 on large common pinacula, respectively. On abdominal segment IX, D1s, D2s, SD1s and MD1s on a large common pinaculum, L group trisetose on a common pinaculum. SV group on abdominal segments I, II, III, VII, VIII and IX consisting of 2, 3, 3, 3, 2 and 2 setae, respectively.

Pupa (Figs 7A, B). Length about 8 mm. Color brown. Frons protruded. Clypeus with two pairs of setae. Maxillae shorter than prothoracic legs. Antennae shorter than mesothoracic legs. Mesothoracic legs shorter than forewings. Distal ends of metathoracic legs exposed. Forewings extending to middle of abdominal segment IV. Spiracles slightly protruded. Abdominal segment X with three pairs of hooked setae.

Material examined. Adult. JAPAN: Honshu: Shizuoka Prefecture (Pref.): Kamo-gun, Minamiizu, 1 ♂1 ♀, 4. V. 1996 (U. Jinbo leg.), UJC; Kannami-cho, Kannami-genseirin, 2 ♂, 19. VI., 1 ♀, 17. VII. 2001 (T. Hirowatari *et al.* leg.), OPU. Aichi Pref.: Toyohashi-shi, Suse, 4 ♀, 2–10. IX. 1997 (M. Sokawa leg.), YNC, Takatsuka-cho, 1 ♂2 ♀, 29. IV. 1995 (T. Mano leg.), TMC, Ishimaki-cho, 1 ♀ , 11. V. 1997 (T. Mano leg.), TMC; Shinjo-shi, Ichikawa, 1 ♀, 30. IV. 1989 (T. Mano leg.), TMC. Mie Pref.: Fujiwara-cho, Mt Fujiwara-dake, 1 ♀, 20. V. 1994 (Y. Nasu leg.), YNC, Mikuni-kyo, 2 ♂, 27. VIII. 1998 (T. Mano leg.), TMC; Yokkaichi-shi, Miyazuma-kyo, 1 ♀, 24. VIII. 1987 (T. Mano leg.), 2 ♀, 3. IX. 1988 (T. Mano leg.), TMC; Daio-cho, Funakoshi, 1 ♀ , 21. V. 1994 (T. Mano leg.), TMC;

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Miyagawa-mura, Yamatodani, 2 ♀ , 19. VIII. 1988 (T. Mano leg.), TMC; Tado-cho, Mihorono, 1 ♀, 20. IX. 1986 (T. Mano leg.), TMC; Owase-shi, Kuri-cho, 1 ♂ 1 ♀, 3. V. 1989 (T. Mano leg.), TMC; Misugi-mura, 1 ♂, 27. V. 1989 (T. Mano leg.), TMC; Ueno-shi, Hijiki, 1 ♂, 16. VIII. 1997 (T. Mano leg.), TMC. Nara Pref.: Takatori-cho, Mt Takatori-yama, 1 ♂, 6. IX. 1991 (Y. Nasu leg.), YNC. Osaka Pref.: Habikino-shi, Syakudo, 2 ♂, 5. IX. 1998 (Y. Nasu leg.), YNC; Izumi-shi, Mt Makio-san, 1 ♂, 18. VI. 1981 (T. Sato leg.), OPU; Kishiwada-shi, Mt Izumikatsuragi-san, 1 ♂, 13. VII. 2002 (Y. Nasu leg.), YNC; Minoo, 1 ♂, 2. VI. 1995 (T. Saito leg.), YNC. Ishikawa Pref.: Zushi-shi, Misaki-cho, 1 ♀, 7. IX. 2002 (A. Tomisawa leg.), ATC. Hiroshima Pref.: Koya-cho, Mt Omangi-yama, 1 ♂, 4. VI. 1996 (K. Yamaguchi leg.), YNC. Tottori Pref.: Aotani-cho, Natsudomari, 1 ♂ 3 ♀, emerged 31. I–20. II. 1995, ex fruits of *Neolitsea sericea* (Y. Nasu leg.), YNC. Yamaguchi Pref.: Oshima-gun, Towa-cho, 1 ♂ 1 ♀, 17. IX. 1990 (T. Mano leg.), TMC. Shikoku: Kochi Pref.: Tosashimizu-shi, Ashizuri-misaki, 1 ♂ 1 ♀, 2. V. 1993 (T. Mano leg.), TMC. Kyushu: Fukuoka Pref.: Kitakyushu-shi, Yamadaryokuchi, 1 ♀, 11. IX. 1996 (T. Yamauchi leg.), YNC; Mt Hiko-san, 1 ♀, 25. IV. 1954 (H. Kuroko leg.), OPU. Miyazaki Pref.: Miyazaki-shi, Nojimagawa, 1 ♀, 12. X. 1999 (A. Nagai leg.), UJC; Nango-machi, Nienami, 1 ♀, 19. IX. 1996 (A. Nagai leg.), UJC. Kagoshima Pref.: Kirishima-cho, Mt Kirishima-yama, 1 ♀, 24. IV. 1958 (S. Issiki & T. Yasuda leg.), OPU; Yakushima Is., Onoaida, 1 ♂ 1 ♀, 8–9. IX. 1979 (Y. Nasu leg.), YNC. Larva. JAPAN: Tottori Pref.: Aotani-cho, Natsudomari, 3 exs, fixed on 20. XI. 1994, *ex* fruits of *N. sericea* (Y. Nasu leg.), YNC. Pupa. The same locality as larva, 1 ♂ 1 ♀, fixed on 31. I. 1995 (Y. Nasu leg.), YNC.

Distribution. Japan (Honshu, Shikoku, Kyushu).

Host-plant. Lauraceae: *Neolitsea sericea* (Bl.) Koidz.

Biological note. Adults fly towards light. The collecting data suggest that the species is at least bivoltine in a year: adults fly in late April to mid June and mid July to September in Honshu. In November larvae boring into the fruits of *Neolitsea sericea* were collected. The larva bored into the seed (Fig. 1C). Under laboratory conditions, fully-grown larva vacated the larval habitat and constructed a cocoon under tissue paper on the bottom of the rearing case. Pupation took place in the cocoon.

Lopharcha kinokuniana Nasu, **sp. nov.** (Figs 1D–G, 2C, D, 3B, 4C, D, 6, 7C, D)

Diagnosis. The species has a dark brown forewing with a brownish semicircular ring on the middle of the costa and five scale tufts, two on the outer edge of the discal cell, one on the middle of the dorsum, the remaining two on the basal 1/3 of wing (Figs 1D, G). The male genitalia are characterized by a slender valva and long aedaeagus (Fig. 2C). The female genitalia are characterized by two bundles of spines (signa) in the corpus bursae (Fig. 3B). The moth is superficially similar to the preceding species, *L. psathyra*, but it can be distinguished from the latter in having a brownish semicircular ring on the middle of the costa of the forewing (instead of two transversal blackish lines on the basal half of the wing) (Figs 1A, D, G), a triangular dorsal cover (eighth tergite) over the male genitalia (instead of a semicircular dorsal cover) (Figs 2B, D), slender valva and aedeagus (Figs 2A, C), and two bundles of spines (signa) in the corpus bursae (instead of a bundle of spines) (Figs 3A, B).

Adult (Figs 1D, G). Wing expanse 11–15 mm. Head dark brown, tips of scales brownish. Antenna simple, dark brown. Labial palpus short, dark brown, tips of scales brownish, inner side whitish. Thorax and tegula dark brown, tips of scales brownish. Forewing elongate oblong, costa slightly curved, apex acute, and tornus round, upperside with five scale-tufts, two on outer edge of discal cell, one on middle of dorsum, the remaining two on the basal

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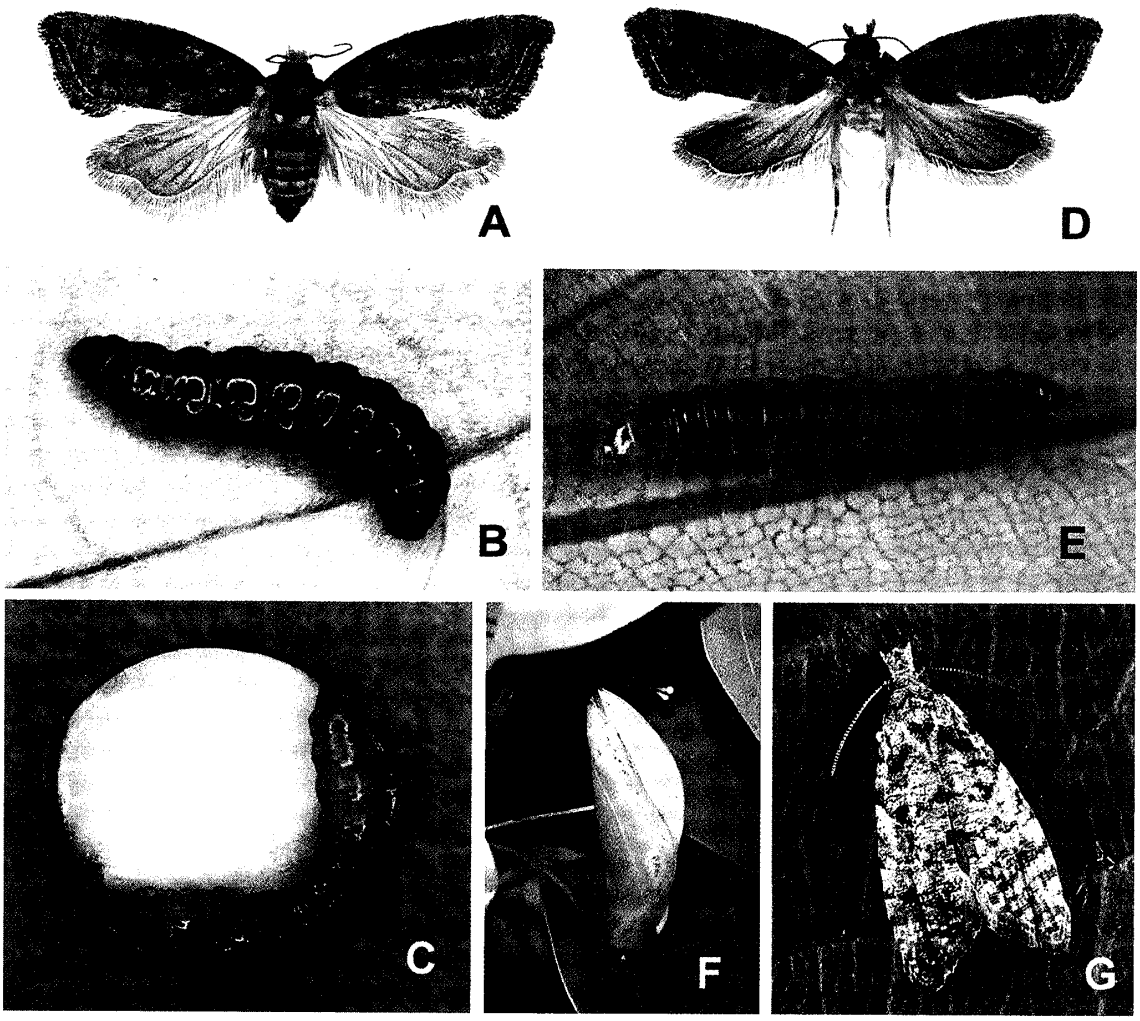

Fig. 1. Adults and larvae of *Lopharcha* spp. A–C. *L. psathyra* Diakonoff. A. Adult, ♀. B. Mature larva. C. Larva in fruit of *Neolitsea sericea*. D–G. *L. kinokuniana* Nasu, sp. nov. D. Holotype, ♂. E. Mature larva. F. A folded leaf of *Cinnamomum japonicum* by larva. G. Adult, resting posture.

1/3. Upperside ground color dark brown, overlaid with brown. Costal fold absent. Eight reddened metallic transverse strigulae margined with brown running from costa to termen or dorsum; the first strigula from costa before apex to middle of termen; the second short, confluent to the first strigula; the third from basal 2/3 of costa to termen before tornus; the fourth and fifth broad, from the middle of costa, confluent in the middle of wing, to basal 2/3 of termen; the sixth broad, from basal 1/3 of costa to basal 1/3 of dorsum; the seventh and eighth indistinct, occupying the basal 1/5 of wing. Costa with a semicircular brownish ring on the middle. Cilia dark brown, with a whitish median line. Underside dark brown, lighter in overlapping area. Hindwing trapezoidal. Upperside light grayish brown, basally whitish; cilia concolorous with wing, with a whitish basal line. Underside light grayish brown.

Male genitalia (Figs 2A, B). Eighth segment with a pair of long deciduous hairpencils, extending into the longitudinal split of the outer side of the valva; eighth tergite enlarged, forming a triangular dorsal cover over the genitalia. Uncus slender, long. Socius finger-

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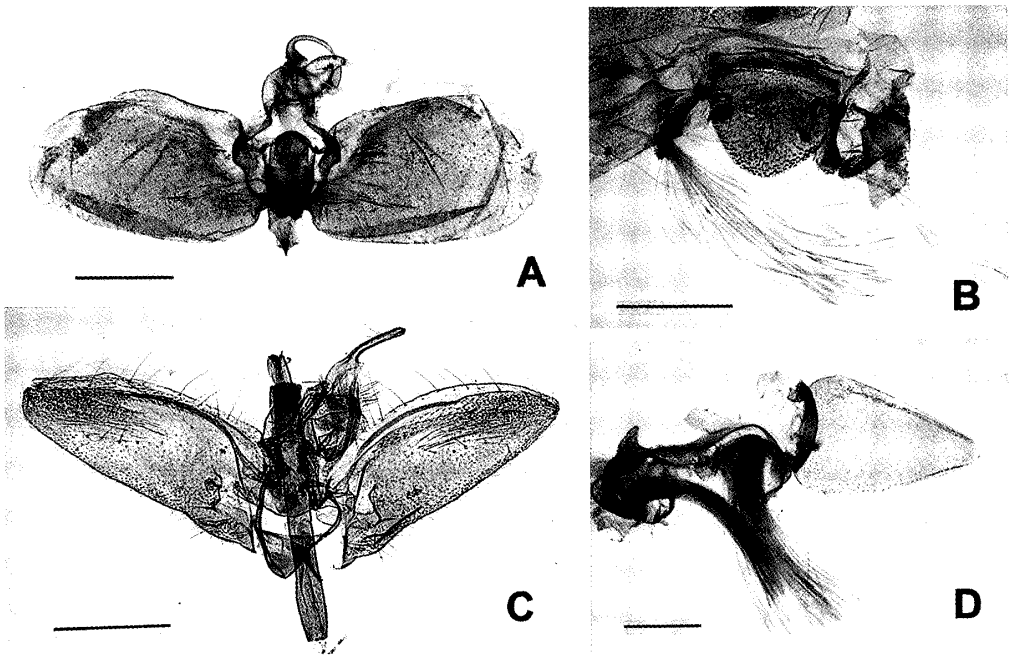

Fig. 2. Male genitalia and eighth tergite of *Lopharcha* spp. A, B. *L. psathyra* Diakonoff. C, D. *L. kinokuniana* Nasu, sp. nov., holotype, YN-1240. B, D: eighth tergite. Scale lines: 0.5 mm.

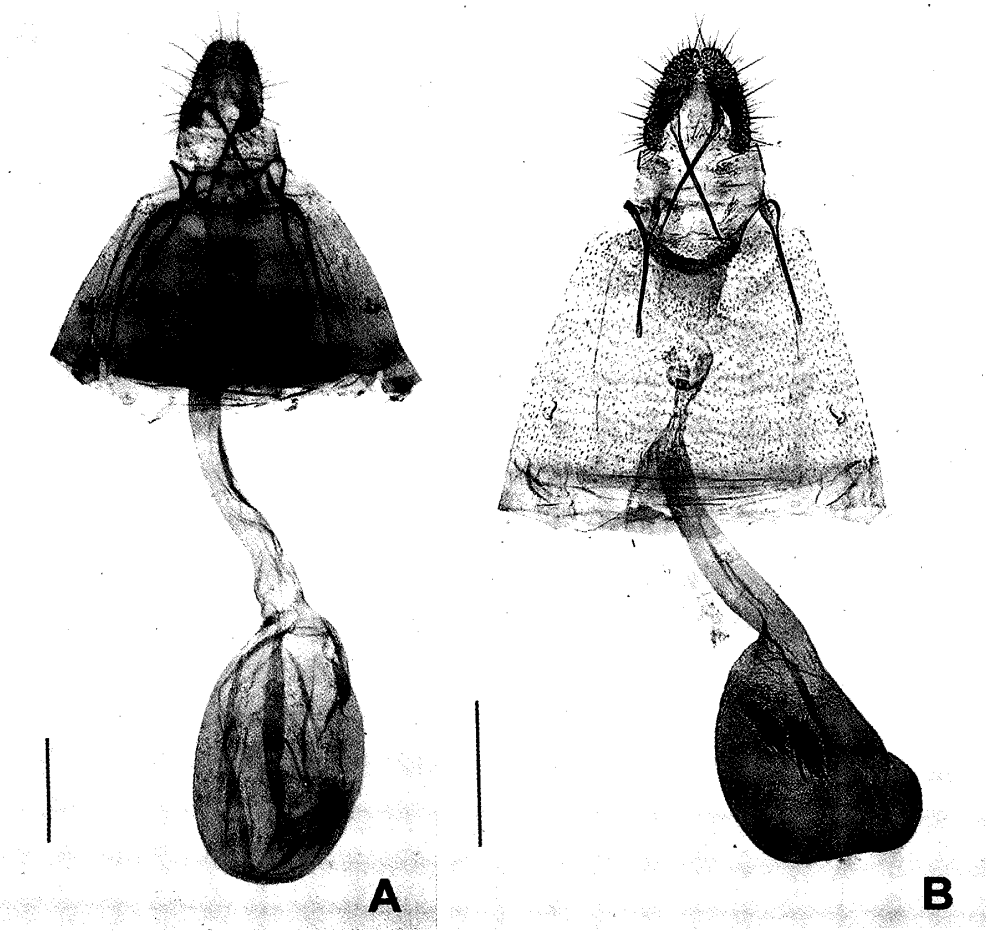

Fig. 3. Female genitalia of *Lopharcha* spp. A. *L. psathyra* Diakonoff. B. *L. kinokuniana* Nasu, sp. nov., YN1023. Scale lines: 0.5 mm.

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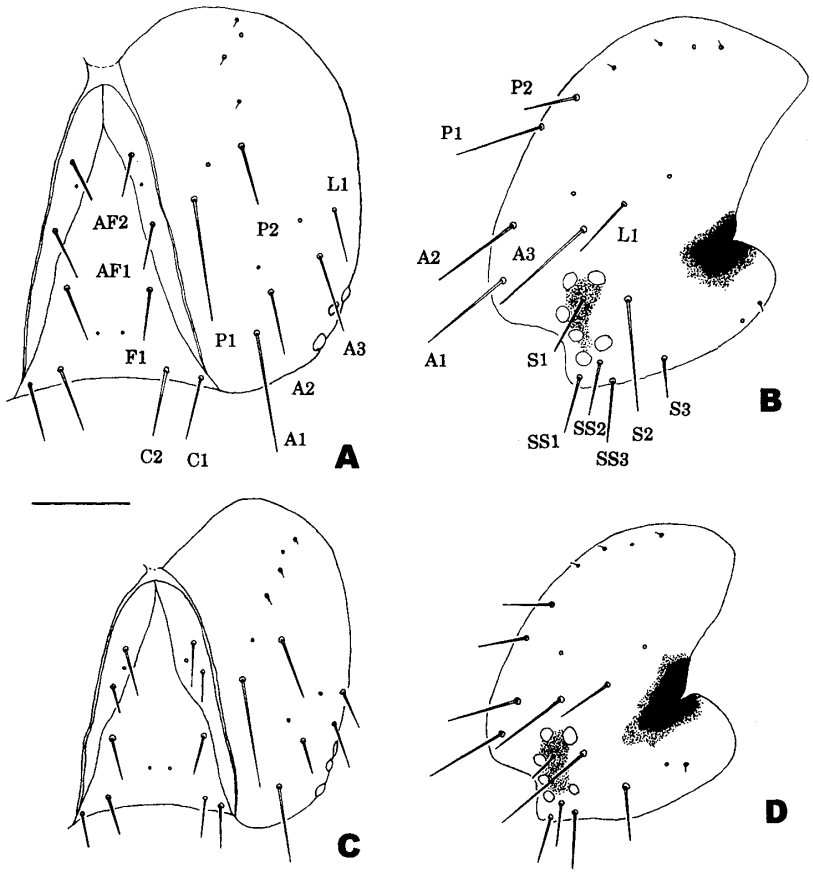

Fig. 4. Chaetotaxies of larval head of *Lopharcha* spp. A, B. *L. psathyra* Diakonoff. A. Frontal view. B. Lateral view. C, D. *L. kinokuniana* Nasu, sp. nov. C. Frontal view. D. Lateral view. Scale line: 0.2 mm.

shaped. Gnathos well developed, a pair of long arms, fused distally. Transtilla a slender bar. Aedeagus a long tube; cornutus absent. Valva slender, blade-shaped, membranous. Vinculum small.

Female genitalia (Fig. 3B). Papillae anales finger-shaped. Apophyses posteriores as long as apophyses anteriores. Lamella antevaginalis a slender band, fused with arms of apophyses anteriores. Bursa copulatrix weakly sclerotized; ductus bursae slender; corpus bursae globular, with two bundles of spines (signa).

Larva (Figs 1E, 4C, D, 6). Last instar length about 6 mm. Head somewhat shorter than broad, brown: stemmatal area and galea dark brown (Fig. 4D); spinneret short, tapering distally. Prothoracic shield pale brown, with two pairs of dark brown spots (Fig. 1E). Thoracic leg brown. Body brownish yellow-brown, becoming somewhat reddish before pupating (Fig. 1E); integument spinulose (Fig. 6D). Crochets on ventral prolegs in a uniordinal circle, 30–35 (Fig. 6D); crochets on anal proleg in a semicircle, 17–18. Small circular plate present in antero-dorsad from ventral proleg on abdominal segments III–VI (Fig. 6D: arrow). Setae pale. Pinacula small, dark brown. Anal plate pale brown (Fig. 6C). Anal fork present, spinulose triangular plate with 10–11 spines on the edge (Fig. 6E).

Chaetotaxy (Figs 4C, D, 6). On head, P1 slightly below the level of AF1, A2 closer to A3 than to A1. On abdominal segments I–VII, SD1 and SD2 antero-dorsad from spiracle, L group trisetose, L1 and L2 on a common pinaculum. On abdominal segment IX, D2s on a

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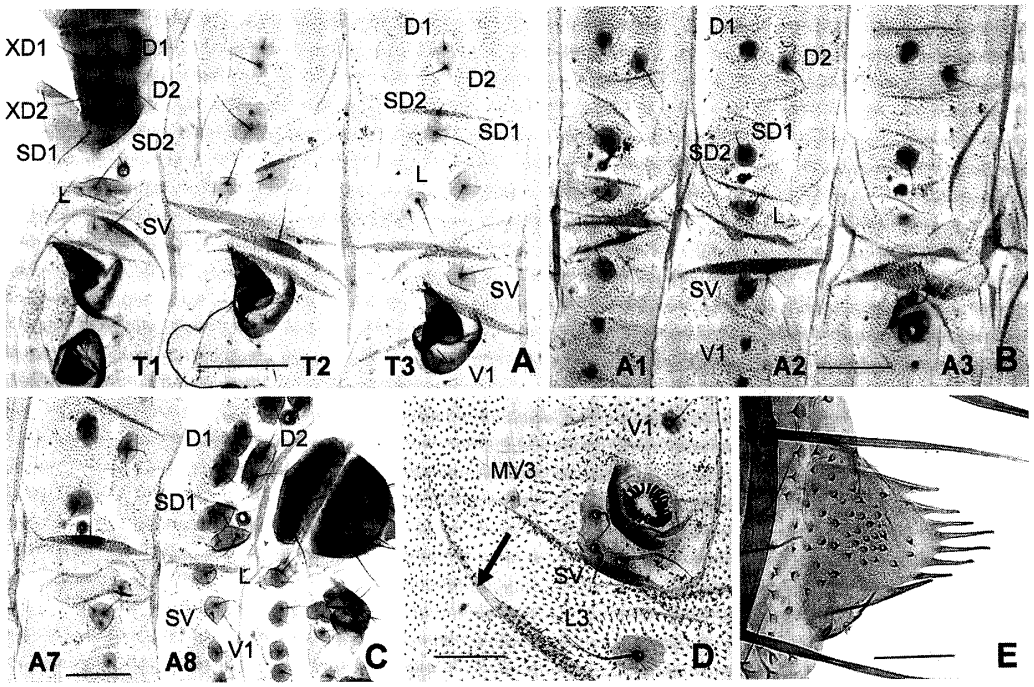

Fig. 5. Chaetotaxies of larval thorax and abdomen, and anal fork of *Lopharcha psathyra* Diakonoff. A. Thorax. B. Abdominal segments I–III. C. Abdominal segments VII–X. D. Small circular plate in antero-dorsad of right ventral proleg on abdominal segment III. E. Anal fork. Scale lines: A, B, C: 0.5 mm; D: 0.2 mm; E: 0.1 mm.

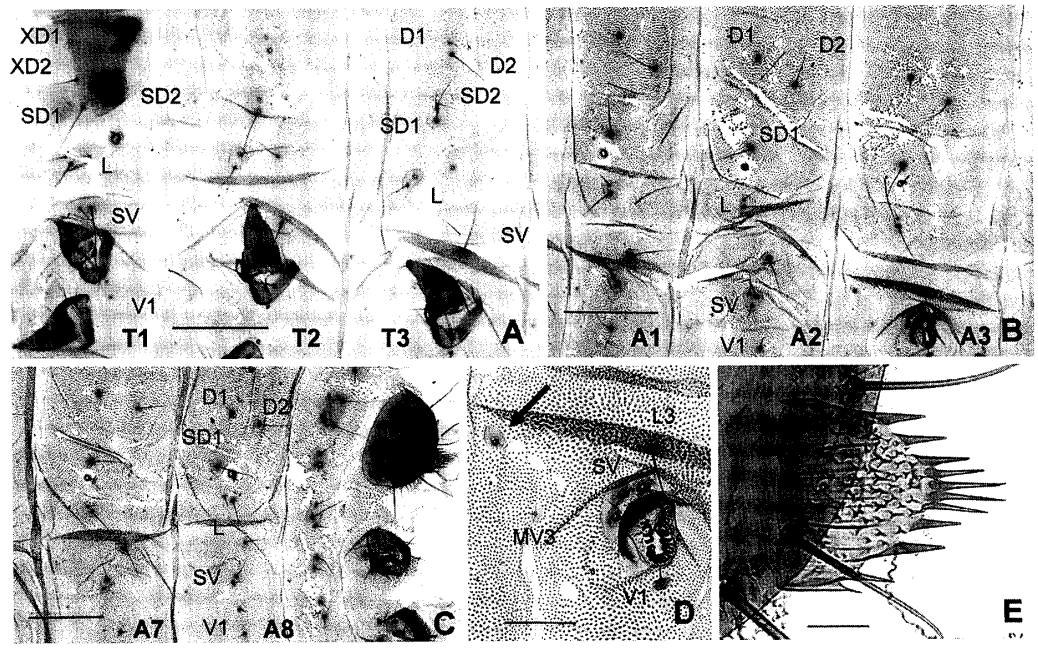

Fig. 6. Chaetotaxies of larval thorax and abdomen, and anal fork of *Lopharcha kinokuniana* Nasu, sp. nov. A. Thorax. B. Abdominal segments I–III. C. Abdominal segments VII–X. D. Small circular plate in antero-dorsad of left ventral proleg on abdominal segment III. E. Anal fork. Scale lines: A, B, C: 0.5 mm; D: 0.2 mm; E: 0.1 mm.

common pinaculum, D1 and SD1 on a common pinaculum, L group trisetose on a common pinaculum. SV group on abdominal segments I, II, III, VII, VIII and IX consisting of 2, 3,

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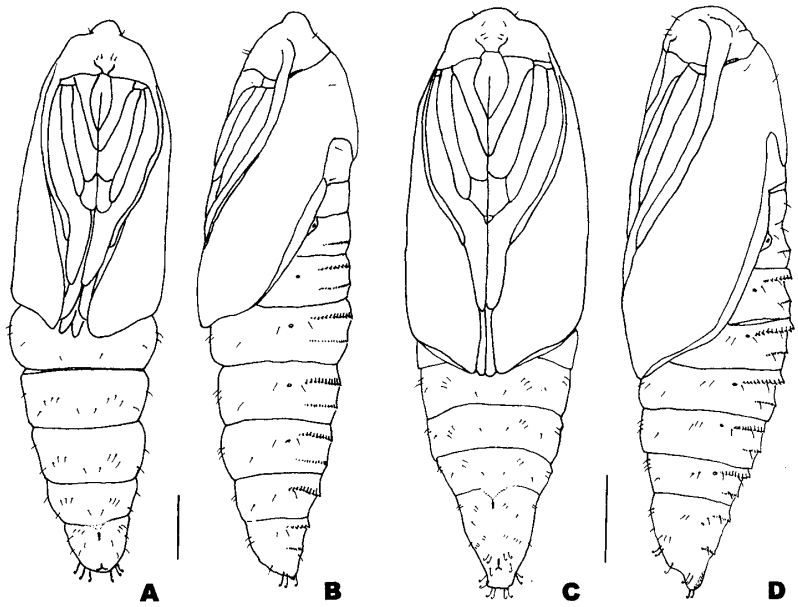

Fig. 7. Pupae of *Lopharcha* spp. A, B. *L. psathyra* Diakonoff. A. Frontal view. B. Lateral view. C, D. *L. kinokuniana* Nasu, sp. nov. C. Frontal view. D. Lateral view. Scale lines: 1 mm.

3, 2, 2 and 2 setae, respectively.

Pupa (Figs 7C, D). Length about 6 mm. Color brown. Clypeus with three pairs of setae. Maxillae shorter than prothoracic legs. Antennae shorter than mesothoracic legs. Mesothoracic legs shorter than forewings. Distal ends of metathoracic legs exposed. Forewings extending to middle of abdominal segment IV. Spiracles slightly protruded. Abdominal segment X depressed ventrally, with two pairs of hooked setae cephalad from anus, a pair laterad from anus, and four pairs on terminal end.

Material examined. Adult. Holotype. ♂, JAPAN: Wakayama Prefecture (Pref.): Kushimoto-cho, Kii-oshima Island, emerged 10–26. VI. 2003, feeding on leaf of *Cinnamomum japonicum* (Y. Nasu leg.), genitalia slide YN-124, OPU. Paratypes. JAPAN: Wakayama Pref.: Kushimoto-cho, Kii-oshima Island, 1 ♀, emerg. 29. VI., 1 ♂ 1 ♀, emerg. 9. VII. 2001 (Y. Nasu leg.), emerg. 2 ♂ 7 ♀, 10–26. VI. 2003 (Y. Nasu leg.), YNC; Susami-cho, Esuzaki, 3 ♀, emerg. 9. VI–7. VII. 2003 (Y. Nasu leg.), YNC. All paratypes are reared from larvae feeding on leaves of *C. japonicum*. Larva. Same locality as holotype, 1 ex., fixed on 27. V. 2001, 9 exs, fixed on 18. V. 2003, feeding on leaves of *C. japonicum* (Y. Nasu leg.), YNC. Pupa. Same locality as holotype, 3 ♂ 4 ♀, fixed on 26. V. 2003 (Y. Nasu leg.), YNC.

Distribution. Japan (Honshu: Wakayama Prefecture).

Host-plant. Lauraceae: *Cinnamomum japonicum* Sieb. ex Nees.

Biological note. The larvae folded down the leaves of *Cinnamomum japonicum* at the midribs, constructing a sword-like case (Fig. 1F), and sometimes folded leaf edges. The larvae fed on the tops of the inner surfaces within the case. The folded leaves were damaged from the tops. Most faeces were stored in the case. Under laboratory conditions, the larva vacated the larval habitat and pupated within the cocoon constructed under tissue paper on the bottom of the rearing case.

Etymology. The species name is derived from the old name of the type locality, *Kinokuni*

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(=Wakayama Prefecture).

Discussion

All five species of *Lopharcha*, of which host-plants are known, feed on the plants of Lauraceae, as Nasu (2006) has already reported. The present two species, *L. psathyra* and *L. kinokuniana*, also fed on the plants of Lauraceae. The genus *Lopharcha* is closely associated with Lauraceae.

The larvae of the present two species show several notable characters. The larvae have small circular plates antero-dorsad from the ventral prolegs on abdominal segments III-VI. The function of the plate is unknown, but the structure is widely distributed in Tortricidae (Komai, 1999; Nasu & Tominaga, 2005; Nasu *et al.*, 2005). These plates usually disappear in the pupal cuticle, but rarely remain (Nasu & Tominaga, 2005). The larva of *L. psathyra* has large common pinacula of D1s and of D2s on abdominal segment VIII and an enlarged dorsal strap-like pinaculum containing D1s, D2s, SD1s and MD1s on abdominal segment IX (Fig. 4C). In contrast, *L. kinokuniana* has no such large pinacula. The former is a borer, but the latter a leaf folder. These characters may be associated with the mode of life (borer) as MacKay (1964) and Nasu *et al.* (2004) have already suggested.

The present two larvae have quite characteristic anal forks, spinulose triangular plate with several spines on the edge (Figs 5E, 6E) The similar anal fork is also found in the larva of *L. insolita* distributed in New Zealand (Dugdale, 1966). Such an anal fork is not found among other species of Tortricidae, whose anal forks are uniformly shaped, a row of straight prongs. The immatures of *Lopharcha* are poorly investigated; however, all the known larvae of the genus, the Japanese two species and *L. insolita* in New Zealand, have such unique anal forks as described. Although the anal fork is an unstable character, which is frequently absent within congeners of Tortricidae, I consider that such an anal fork is an autapomorphy for the genus because of the shared possession of the unique anal fork among three species distributed in Japan and New Zealand, which are far away geographically.

Acknowledgements

I thank the following lepidopterists, Dr U. Jinbo (Tokyo University, Tokyo), Dr F. Komai (Osaka University of Arts, Kanan-cho), Mr T. Mano (Toyota Yahagi River Institute, Toyota-shi), the late Mr M. Sokawa (Toyohashi-shi), Dr T. Hirowatari (OPU), Dr T. Saito (Ikeda-shi), Ms H. Yamamoto (Sakai-shi), Mr A. Tomisawa (Ishikawa Insect Museum, Hakusan-shi), Mr K. Yamaguchi (Hiroshima-shi) and Dr T. Yamauchi (Toyama Institute of Health, Izumi-shi), for gifts of the specimens, allowing me to examine them and kind support.

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摘　　要

Lopharcha 属 (鱗翅目, ハマキガ科, マダラハマキガ亜科, Polyorthini 族) の幼生期と日本からの新種記載および属の固有新形質 (那須義次)

日本産 *Lopharcha* 属2種の幼生期を記載した. これら2種の幼虫は, ハマキガ科のなかでは非常にユニークな形をした尾叉をもつことが判明した. 2種の尾叉はいずれも三角形で表面に微小な刺を, 外縁にやや長めの刺をもつ. 同様な尾叉はニュージーランドに分布する同属の *L. insolita* (Dugdale) に見られるだけである. 幼生期が明らかな本属の3種がともに特徴的な尾叉をもつことから, この形質は本属の固有新形質であると考えられた.

スジケマダラハマキ *Lopharcha psathyra* Diakonoff

成虫は4月下旬から6月中旬, 7月中旬から9月まで採集されているので, おそらく年2化と思われる. 11月にシロダモの実に潜っている幼虫を得た.

分布: 本州, 四国, 九州.

ヤブニッケイマダラハマキ (新称) *Lopharcha kinokuniana* Nasu, sp. nov.

前翅開張 11–15 mm. 前翅は黒褐色で, 隆起鱗粉の束をもつ. 外部表徴は前種に類似するが, 本種の前翅は前縁に半円形の褐色リングをもつこと (前種は基部 1/2 に明瞭な2黒褐色横線を有する) で区別できる. ♂♀交尾器による識別は容易である.

幼虫はヤブニッケイの葉を中肋から内側に二つに折り曲げ刃状のケースを造り, 中に潜んで葉裏の表面を摂食する.

分布: 本州 (和歌山県).

(Accepted April 5, 2008)

Published by the Lepidopterological Society of Japan,
5-20, Motoyokoyama 2, Hachioji, Tokyo, 192-0063 Japan

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